# Comparison of Turbulence Modeling Strategies for Indoor Flows

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## Objectives

• Modeling and simulation of the air flow inside the IFL(indoor flowfield laboratory at Syracuse University) using the CFD flow modeling software Fluent.

• Studying the effects of various inlet conditions (turbulence intensity, experimentally measured profiles) on the flow dynamics .

• Comparing the constant coefficient and the dynamic LES models.

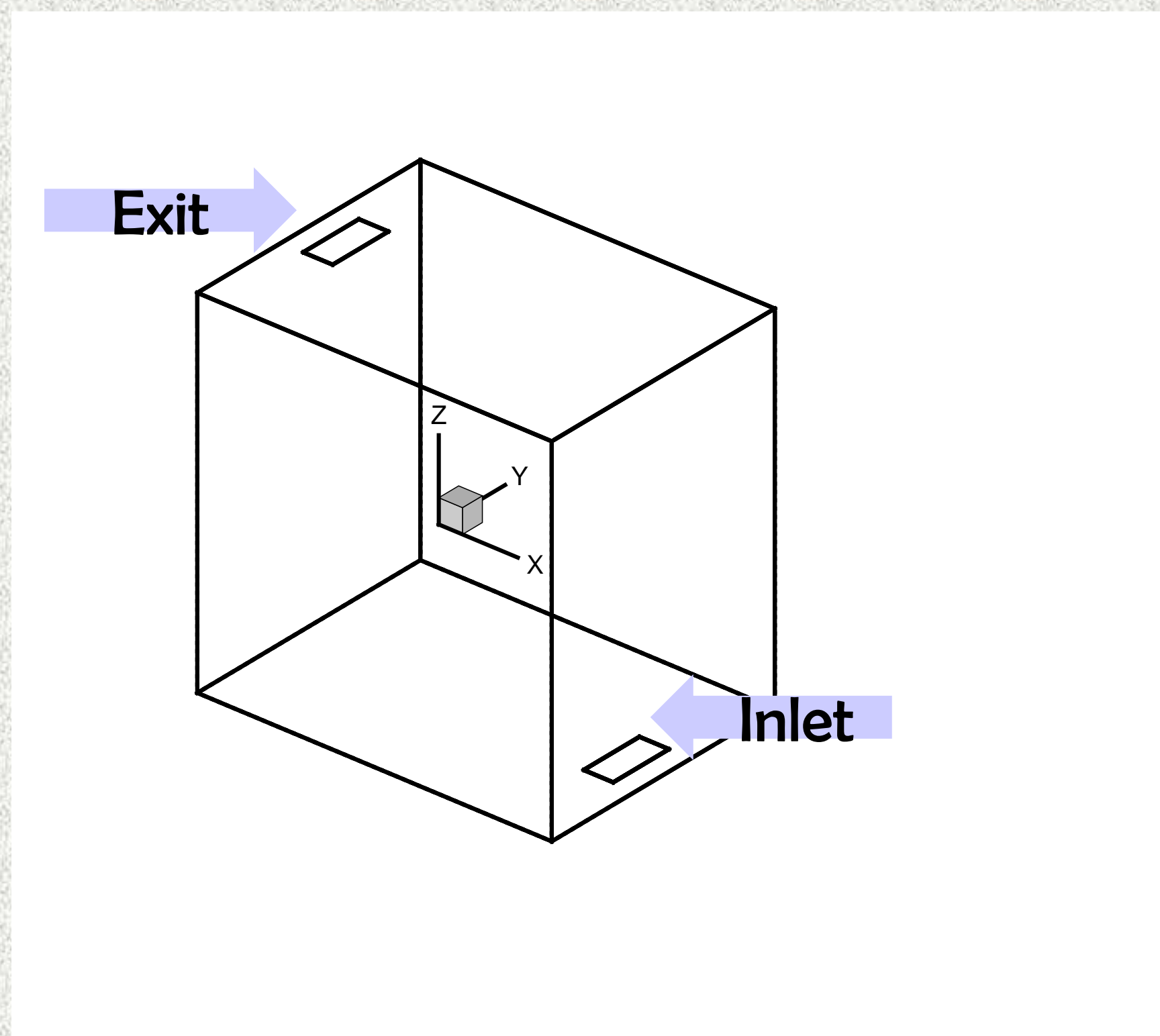• Studying the performance of k-ε model as compared to LES model.



Fig.1 Indoor flowfield laboratory chamber

## Summary of the results

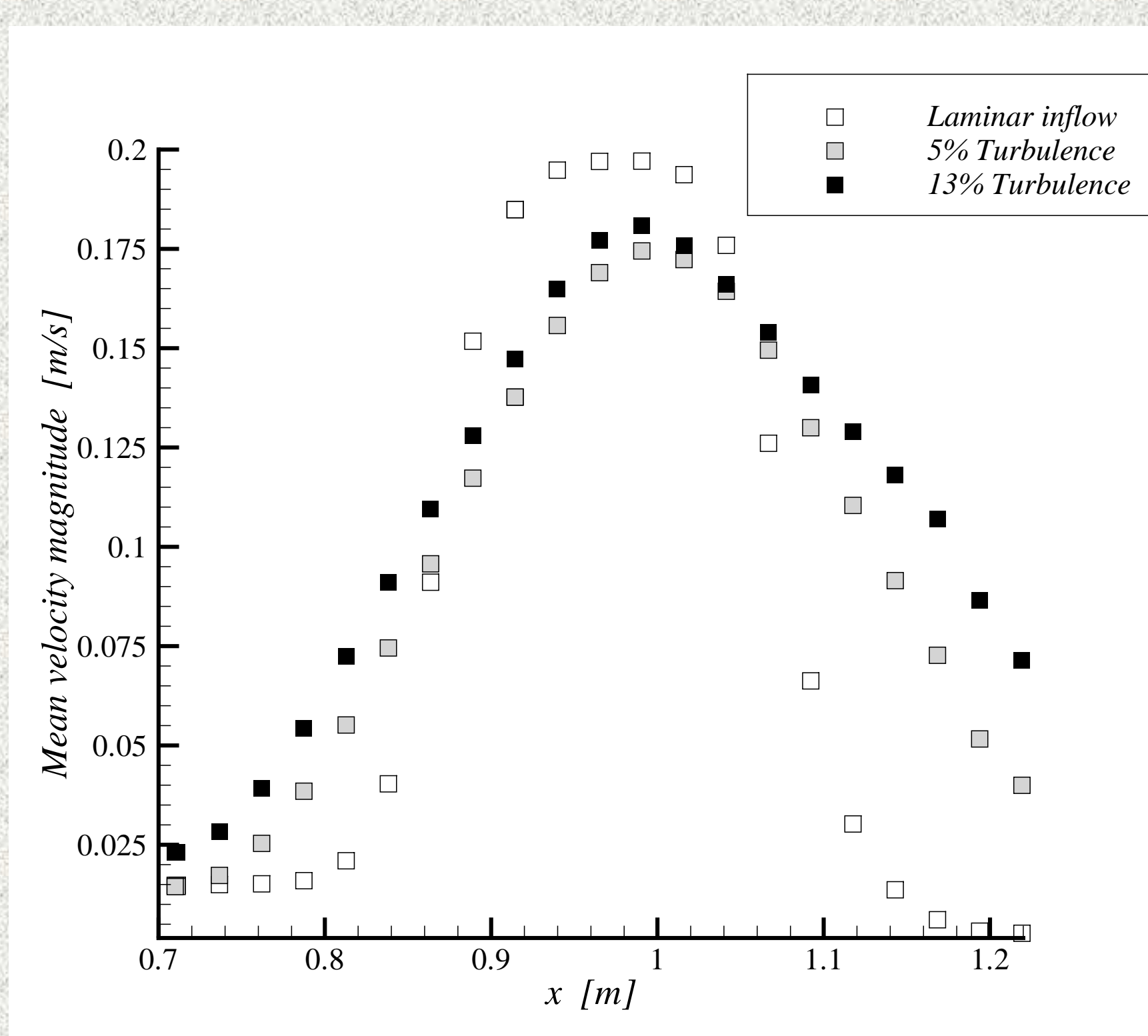### 1. Effects of Inlet turbulence intensity using the constant coefficient LES model



Fig.2 Mean velocity magnitude at mid-height (z/L=0)

• Significant differences between the laminar inflow case and the two cases with turbulent inlet conditions.

• The jet spreads and mixes with the room air faster when seeded with inlet turbulence.

• Modest differences between the 5% and 13% inlet turbulence intensity cases as the jet develops into a fully-developed state independent of further inlet turbulence.

### 2. Effects of experimentally determined profiles.

• The flow is sensitive to the inflow details close to the inlet.

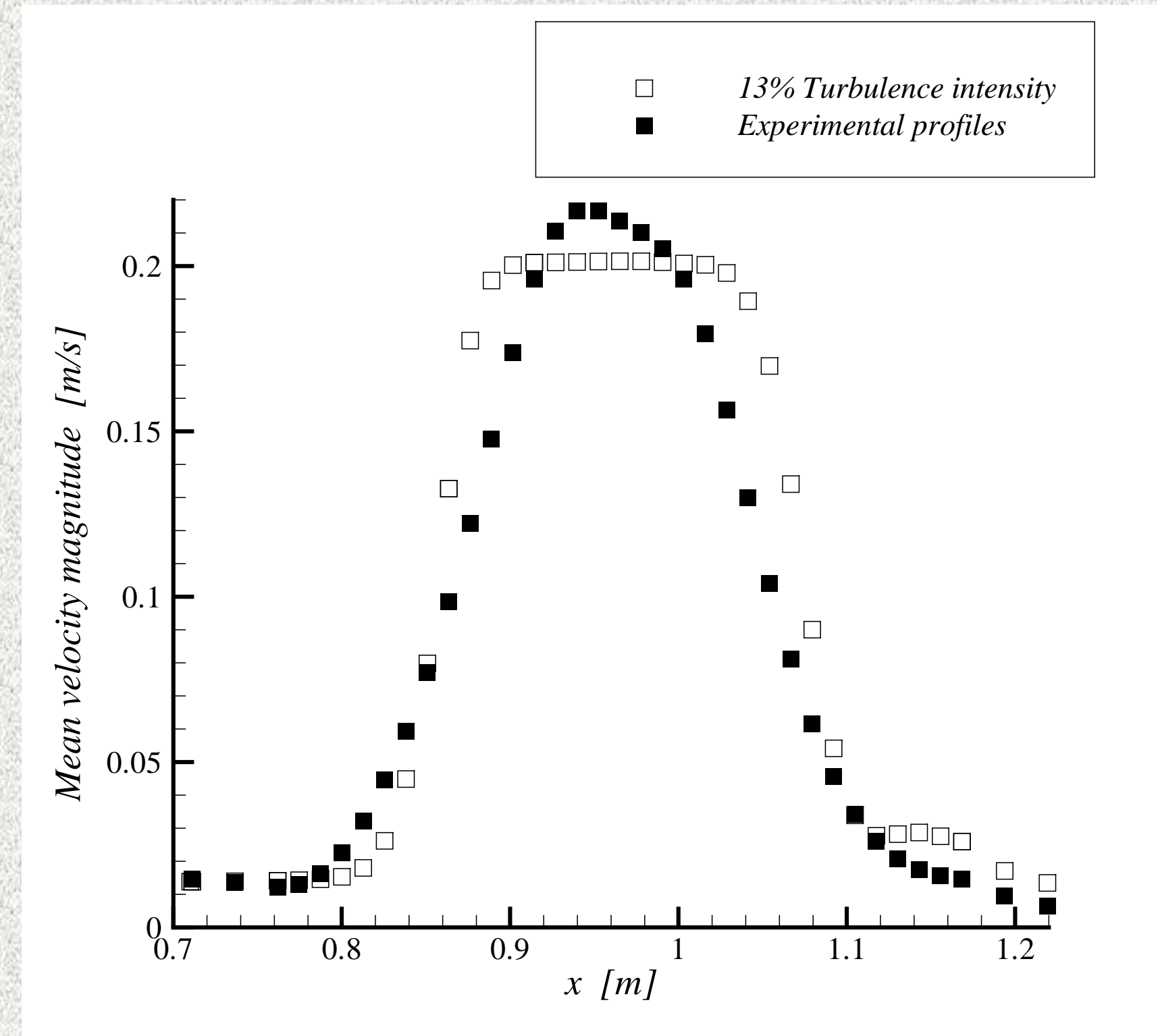• The effects of inlet profile details become less pronounced further away from the inlet.
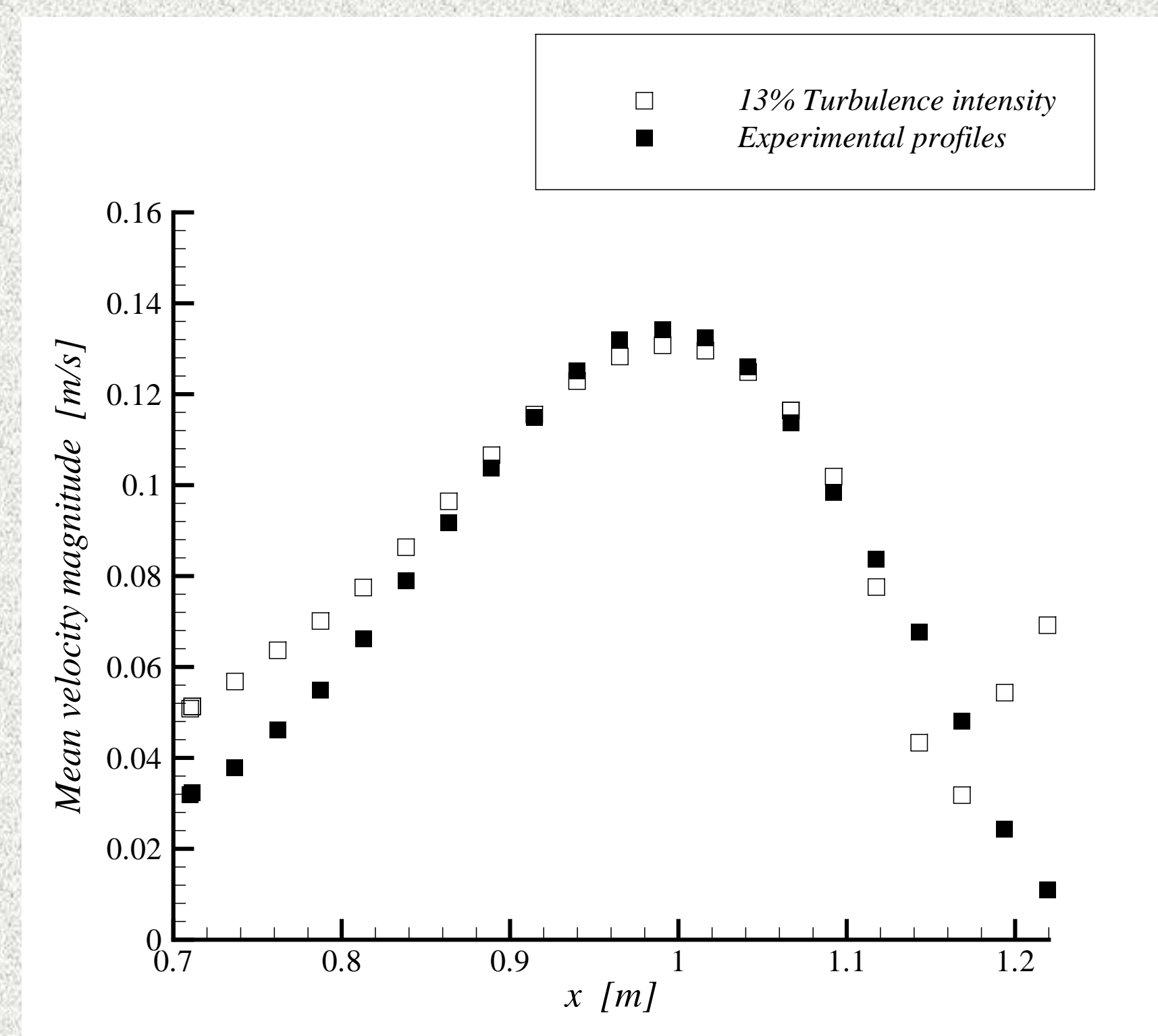


Fig.3 Mean velocity magnitude near inlet (z/L=-.8)



Fig.4 Mean velocity magnitude near ceiling (z/L=.75)

### 3. Comparison of the constant coefficient and the dynamic LES models.

• Model differences (not shown) are small especially far from the inlet where most of the turbulent kinetic energy is resolved.

### 4. Comparison of k-ε and LES models

• k-ε model captures the mean velocity reasonably well and the results are in reasonable agreement with LES at high levels of inlet turbulence intensity.

• k- ε model shows no sensitivity to the level of inlet turbulence intensity.

• k- ε model fails to capture the slow development of the jet into a turbulent state resulting in over prediction of the turbulence levels and the spreading rate close to the inlet.

• k- ε model fails to capture the complicated flow pattern near the ceiling and as a result under predicts the turbulence levels there.
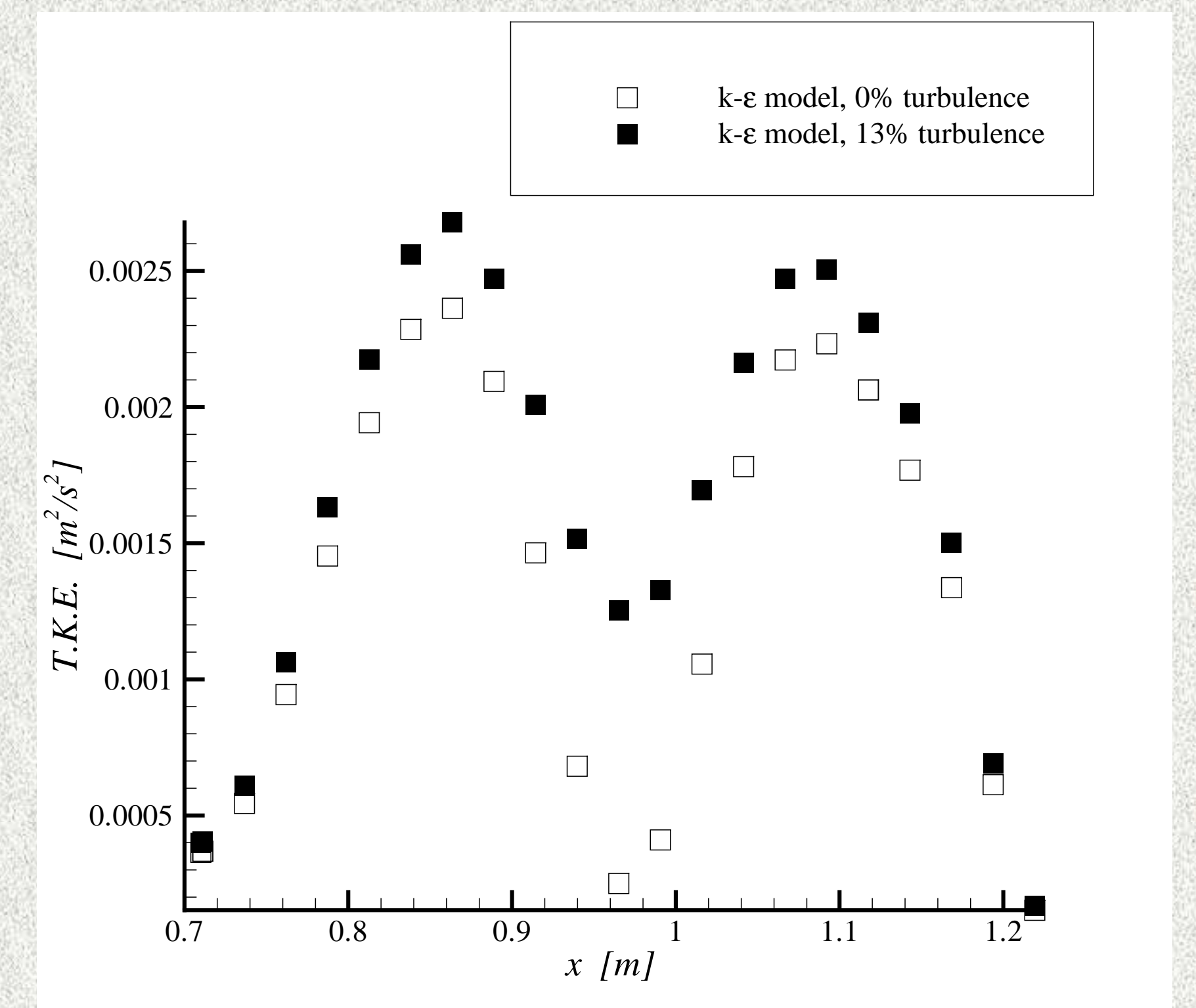


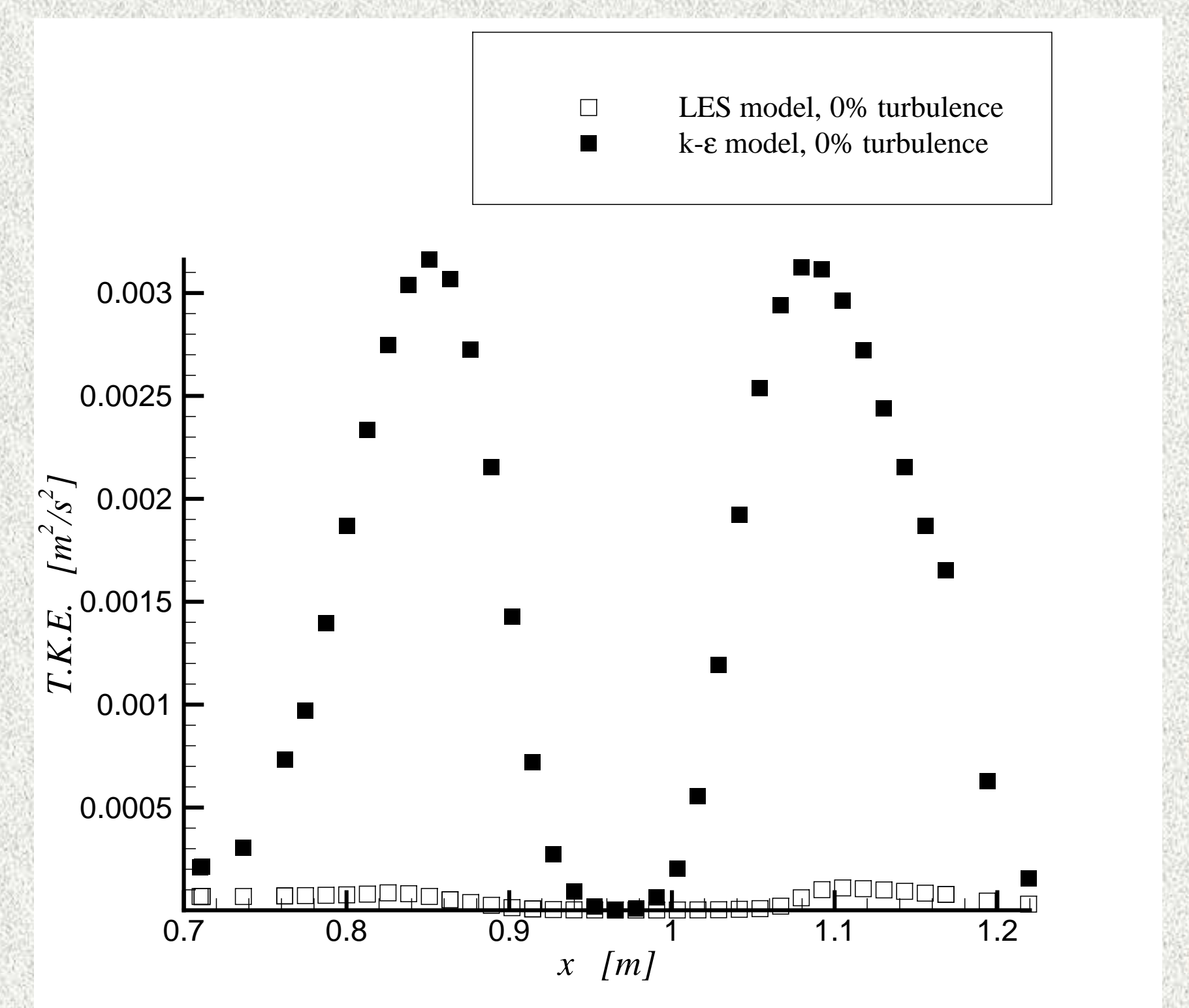Fig.5 turbulent kinetic energy from k-ε model near the inlet (z/L=-.6)



Fig.6 turbulent kinetic energy from k-ε & LES models near the inlet (z/L=-0.8)
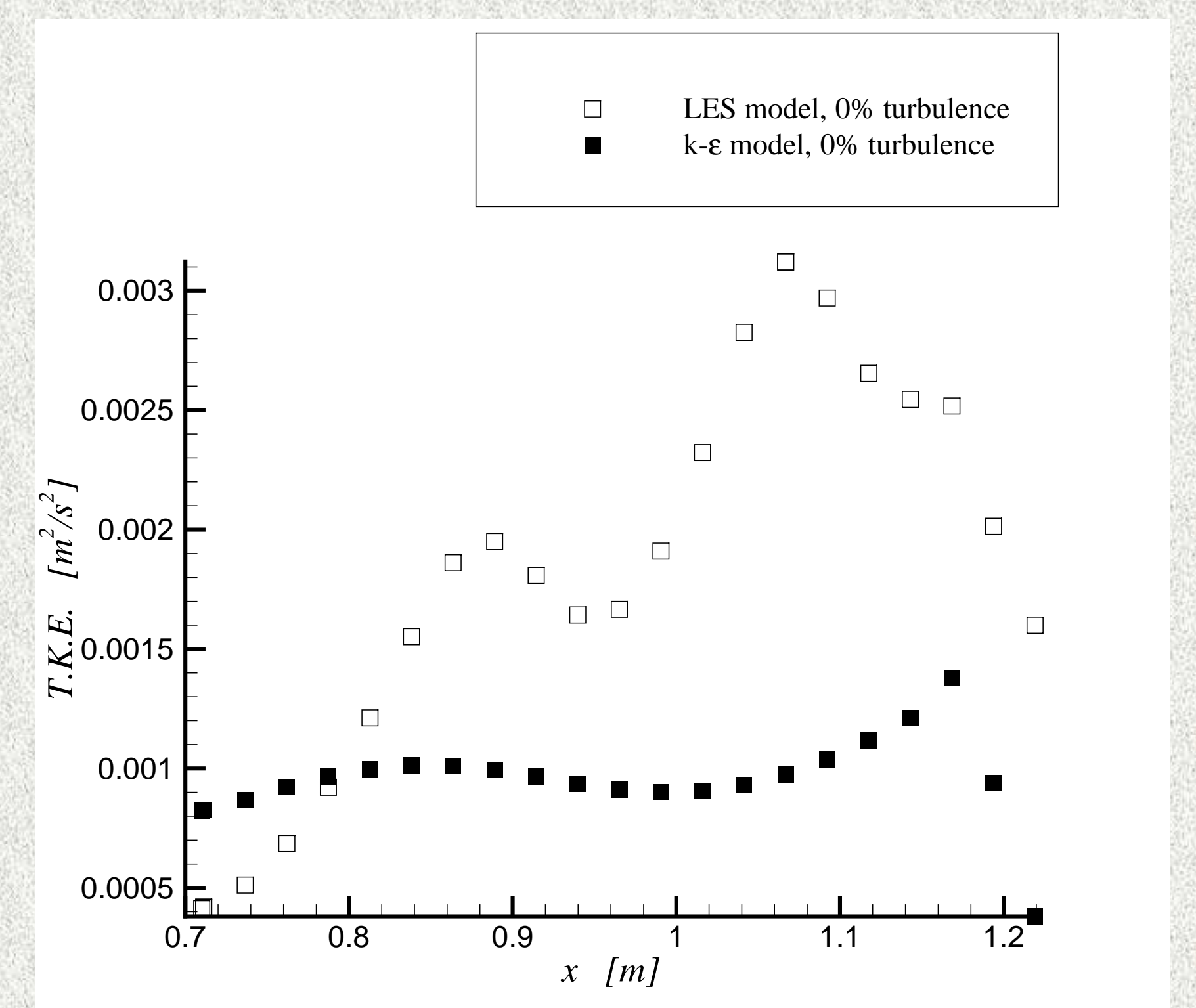


Fig.7 turbulent kinetic energy from k-ε &LES models near the ceiling (z/L=0.75)

## References

• Abdilghanie, A.M., Collins, L.R., Caughey, D.A., "Comparison of Turbulence Modeling Strategies for Indoor Flows", J.Fluids Eng.May 2009, Volume 131, Issue 5, 051402.

• D. Marr, 2007 " Velocity Measurements in the Breathing Zone of a Moving Thermal Manikin within the Indoor Environment", Ph.D. thesis, Syracuse University.